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Silver Bow, Powell

ECOLOGICAL STUDIES OF SILVER BOW AND BLACKTAIL CREEKS AND UPPER CLARK FORK RIVER: SILVER BOW, POWELL AND DEER LODGE COUNTIES, MONTANA

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A REPORT

BY

ELMER E. GLESS, ASSOCIATE INVESTIGATOR
DEPARTMENT OF BIOLOGICAL SCIENCES

CONSTITUTING A PART OF A CONTRACT PROPOSAL

ENTITLED

INFLUENCE OF INDUSTRIAL, MUNICIPAL AND PRIVATE WASTES
ON WATER QUALITY OF A PORTION OF THE UPPER CLARK FORK
RIVER DRAINAGE - A RECONNAISSANCE STUDY.

MARVIN R. MILLER, CHIEF HYDROLOGY DIVISION
MONTANA BUREAU OF MINES AND GEOLOGY, PRINCIPAL INVESTIGATOR

FOR

MONTANA DEPARTMENT OF HEALTH
AND ENVIRONMENTAL SCIENCES

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INTRODUCTION

As stated in the project proposal: "In order to make an initial assessment of the recovery of Silver Bow Creek and to make recommendations for its reclassification, baseline information on the water and stream-sediment quality is necessary". And further, "Knowing the present biological system of the Silver Bow Creek drainage will be important for baseline data on the present biological environment, in assessing the biological recovery of the drainage, and in evaluating all manmade pollution sources within the drainage".

Therefore a study of existing bacterial and invertebrate ecosystems of both Blacktail Creek and Silver Bow Creek from Butte to Warm Springs and the Upper Clark Fork River was conducted during the summer months of 1972 and again during the spring of 1973.

The sample stations descriptions are listed in APPENDIX I and are as previously determined. These are labeled according to types of evaluation. Hence, relative to this particular portion of the study, "I" indicates invertebrate sampling and "B" indicates bacterial sampling.

Additional stations, i.e. 33 through 39, APPENDIX II, and S-1 through S-8, APPENDIX III, were located and added to the study during its course.

BACTERIAL STUDIES

In keeping with Standard Methods, 13th Edition, 1971, membrane filtration of water samples was conducted for Total, Fecal and Fecal Streptococcal Coliform identification. Water was collected in four-ounce sterile screw-cap glass bottles each containing 0.1 ml of 10 percent sodium thiosulfate. All samples were stored on ice in a styrofoam cooler immediately after collection until testing. All samples were tested within 90 minutes of collection.

All samples were thoroughly shaken before withdrawing the desired quantity of water for filtration. Any quantity of 1 ml or less was measured in a pipette and dropped into sterile phosphate buffer water in the filtration funnel before passing through the sterile membrane filter (Millipore Corporation Filter type HAWG 04750, 45 micron pore size). Water samples larger than 1 ml were measured in graduated cylinders and then rinsed through the filter with sterile phosphate buffer water. After filtration, the membrane filter was placed on pads (Millipore) that had been previously saturated with 1.8-2.0 mls of M-coliform broth (BBL) for Total Coliform, m FC medium (DIFCO) for Fecal Coliform, and m Enterococcus medium (DIFCO) for Fecal Streptococcal Coliform counts. The filtering apparatus and glassware were sterilized between samples by an ultraviolet light chamber. Pads with membranes were held in disposable 50 X 12 mm, sterile, plastic petri dishes. Inoculated dishes for Total and Fecal Streptococcol Coliforms were inverted and incubated at 35° C in a Thelco Corporation Model 4 incubator. Inoculated petri dishes for Fecal Coliforms were placed in a Precision Corporation water bath equipped with an adjunct Bronwill Thermomix II TN heater-stirrer for precise maintenance of the required 44.5° C temperature. The samples were placed in the water bath by inverting glass finger bowls (8x3 inches) over a screen grid upon which the petri dishes had been placed. This technique afforded an appropriate air space under water.

All colonies after required incubation periods were counted using a 15X steroscopic microscope. Illumination was by a diffused fluorescent source.

Coliform populations at indicated stations with station descriptions, dates, time of day, volume and water temperatures are shown in TABLE I.

All coliform populations are expressed as number per 100 mls of sample. Routinely, water temperature was taken with each sample. Calculations of Geometric Means for all evaluations with population ranges and an average of the ratios of Fecal Coliform per Fecal Streptococcal counts (FC/FS) are presented in TABLE II.

For the most part the populations of bacteria are representative of those found in high mountain waters in other areas of the state (Bissonnette, 1971). Generally the waters found outside or above the metropolitan area are pristine as are most tributaries to Silver Bow Creek.

Evaluations of Silver Bow Creek proper were erratic in the early stages of the study. Membrane filtering was difficult to conduct because of heavy sediment plugging the membranes. Multiple tube fermentations were not completely successful because the physical and/or chemical properties caused a coagulation and precipitation of the media in the test tubes. Samples from stations 12 and 22 were not successful at all. Samples of stations 13, 14, 15, and 18 showed improvement with time. It is believed that the indicated improvement will coorelate directly with Anaconda Company, Butte Operations, Environmental Engineering efforts for removal of particulates and improvement of the chemical nature of the water of Silver Bow Creek.

Columbia Gardens Creek (Stations 11, 11A, 11A1, 11A2, 11A3, 11B, and 11C) were all unusually high. Consequently, Fecal Coliform and Fecal Streptococcal evaluations were conducted. The ratios are presented in TABLES I & II. It was ultimately determined that the Columbia Gardens septic tank effluent running into the creek was the probable source of the contamination.

Examination of Basin Creek from Elizabeth Warren Drive to its confluence with Blacktail Creek (Station 7) and Blacktail Creek from its confluence with Basin Creek to its confluence with Silver Bow Creek (Station 12) was conducted by walking through the water and visually siting potential pollution sources. Stations labeled S-1 through S-8 are the results of those efforts and are described in APPENDIX III. All effluents found are described for exact location. All Fecal Coliform to Fecal Streptococcal ratios except one (Station S-4) indicate human contamination.

Additional stations located and added during the course of the study are numbered 33 through 39 (APPENDIX II).

Station 33 was immediately below the Basin Creek Reservoir, No ratio of Fecal Coliform to Fecal Streptococcal organisms was determined since no fecal coliform organisms developed in the media. Fecal Streptococcal organisms were very few while the Total Coliforms were unusually high. This is believed to be because a series of ponds below the lake had recently been drained revealing very muddy and silty areas. Probably most coliforms were of the soil variety.

Station 34 a "storm sewer" outlet at the foot of Excelsior Avenue was examined several times. It was found to carry raw human sewage, inclusive of sanitary napkins, condoms, and whole clumps of fecal material. Initially the FC/FS ratio was very high. However, after a meeting with State and County Health and Sanitary personnel in May, 1973, the ratio dropped off to an acceptable number.

One other "storm sewer" Outlet was found to have an excessively high FC/FS ratio, i.e. Station 38 located east of Harrison Avenue and emptying into Silver Bow Creek.

Warm Springs Creek at its mouth was somewhat higher than most other stations. While FC/FS ratios were not determined it is believed the high count was the result of irrigation water flowing through pasture land.

TABLE I COLIFORM POPULATIONS AT INDICATED STATIONS WITH DATES, TIME OF DAY, VOLUME AND WATER TEMPERATURE

STATION	DATE	TIME	TOTAL COLIFORM VOL (MLS)	TOTAL COLIFORM NOS. PER 100 MLS	FECAL COLIFORM VOL (MLS)	FECAL COLIFORM NOS. PER 100 MLS	FECAL STREP VOL (MLS)	FECAL STREP NOS. PER 100 MLS	WATER TEMPERATURE AT COLLECTION (°C)	RATIO FC/FS
1		Blacktail Creek above Thompson Park; on Roosevelt Drive, 1.2 miles above Milwaukee trestle at log cabin ranch house, below fence.								
	June 12, '72	9:15 A	20	*70					10°	
	July 14, '72	9:15 A	150	*12					13°	
	July 17, '72	8:50 A	75	100					12°	
2		Blacktail Creek below Thompson Park at Nine-mile (Junction of Continental Drive and U.S. Highway 10). South side of Highway 10.								
	June 12, '72	9:25 A	20	*170					8°	
	July 14, '72	9:25 A	150	*14					12°	
	July 17, '72	9:00 A	75	100					11°	
3		Blacktail Creek above Country Club on Country Club Drive exit at crossing about ¼ mile west of Country Club Drive exit.								
	June 12, '72	9:30 A	15	490					9°	
	July 14, '72	9:30 A	25	200					11°	
	July 17, '72	9:10 A	20	440					10°	
4		Blacktail Creek above Basin Creek and below Country Club immediately above convergence with Basin Creek at Father Sheehan Park.								
	June 12, '72	9:40 A	20	*190					10°	
	July 14, '72	9:45 A	50	*220					10°	
	July 17, '72	9:35 A	15	210					10°	
	March 24, '73	1:15 P	60	40					8°	
5		Basin Creek above Blacktail Creek at end of culvert under the Interstate 90 at Father Sheehan Park.								
	June 12, '72	9:40 A	19	400					10°	
	July 14, '72	9:45 A	75	29					13°	
	July 17, '72	9:35 A	60	55					12°	
	March 24, '73	1:15 P	30	210					6°	

* Non-Ideal Colony Counts.

TABLE I, CONT.

			TOTAL COLIFORM		FECAL COLIFORM		FECAL STREP			
STATION	DATE	TIME	VOL (MLS)	Nos.Per 100 MLS	VOL (MLS)	Nos.Per 100 MLS	VOL (MLS)	Nos.Per 100 MLS	WATER TEMPERATURE AT COLLECTION (°C)	RATIO FC/FS
6	Blacktail below Basin Creek, 100 yards downstream from convergence with Basin Creek at Father Sheehan Park.									
	June 12, '72	9:40 A	20	*240					10°	
	July 14, '72	9:45 A		TNTC						
	July 17, '72	9:15 A	15	340					10°	
	March 24, '73	1:15 P	120	48					8°	
7	Blacktail Creek above Silver Bow Creek.									
	June 12, '72	10:00 A	19	610					11°	
	July 14, '72	9:50 A	15	*980					11°	
	July 17, '72	9:35 A	15	150					10°	
11	Stream from Columbia Gardens (Horse Canyon), ditch along railroad immediately above the junction of Continental Drive and Montgomery Avenue (road to Columbia Gardens).									
	June 12, '72	9:50 A	1	7200					10°	
	June 14, '72	11:35 A	1.7	7000					19°	
	June 15, '72	10:30 A	1.7	4000					16°	
	June 19, '72	10:10 A	2.5	2800			15	350	12°	
	June 22, '72	10:10 A	2.5	3300			1	3000	13°	
	July 19, '72	9:15 A	1	5000			1	9200	8°	
	July 25, '72	8:50 A	1	2300	5	760	5	1000	10°	0.76:1
	July 27, '72	9:25 A	2.5	*4700	5	*2000	1	2300	12°	0.9:1
	July 31, '72	9:05 A	315	3100	3.5	3100	3.5	1400	13°	1.64:1
11A	Columbia Gardens Creek 0.7 miles above Station 11 on Columbia Gardens Road.									
	June 15, '72	10:25 A	1	5000					10°	
	June 19, '72	10:05 A	1.2	9700			4	1300	7°	
	June 22, '72	10:05 A	1.5	7100			4	*440	8°	
	July 19, '72	9:20 A	1	6600	5	1400	6	*380	8°	3.42:1
	July 31, '72	9:10 A	3.5	3200	3.5	*340	3.5	*110	11°	3.09:1
11A1	Columbia Gardens Creek above Columbia Gardens Septic Tank.									
	July 25, '72	9:20 A	30	260	30	*7	25	120	9°	0.05:1

STATION	DATE	TIME	TOTAL COLIFORM VOL (MLS)	TOTAL COLIFORM Nos.Per 100 MLS	FE COLIFORM VOL (MLS)	FE COLIFORM Nos.Per 100 MLS	FECAL STREP VOL (MLS)	FECAL STREP Nos.Per 100 MLS	WATER TEMPERAT AT COLLECTION (°C)	RATIO FC/FS
11A1 Cont.	July 27, '72	9:40 A	25	150	75	*17	6.5	*250	10°	0.067:
	July 31, '72	9:20 A	25	130	175	*10	30	89	11°	0.11:1
11A2		Columbia Gardens Septic Tank Sewage Effluent.								
	July 25, '72	9:00 A	25	0	31	0	1	*100	9°	0
	July 27, '72	9:35 A	0.1	*10,000	1.1	*900	1.0	*100	10°	9.0:1
	July 31, '72	9:20 A	3.5	2300	8.5	*390	7.5	85	11°	4.58:1
11A3		Columbia Gardens Creek below road culvert immediately below Septic Tank (11A1 and 11A2).								
	July 25, '72	9:20 A	25	160	25	*12	25	84	9°	0.12:1
	July 27, '72	9:45 A	1	6700	5	1100	1	*400	10°	2.75:1
	July 31, '72	1:20 P	1	2600	6	*370	15	*170	11°	2.19:1
11B		Columbia Gardens Creek tributary 20 feet south of Station 11.								
	June 22, '72	9:55 A	1	3200			19	*120	7°	
	July 19, '72	9:35 A	6	1200			31	320	7°	
	July 25, '72	8:40 A	5	460	25	*4	25	280	8°	0.03:1
11C		Columbia Gardens Creek above Merry-Go-Round in picnic area.								
	July 19, '72	9:25 A	5	1300			31	160	8°	
	July 25, '72	9:10 A	30	53	31	1	30	40	9°	0

TABLE I, CONT.

STATION	DATE	TIME	TOTAL COLIFORM VOL (MLS)	TOTAL COLIFORM Nos.Per 100 MLS	FECAL COLIFORM VOL (MLS)	FECAL COLIFORM Nos.Per 100 MLS	FECAL STREP VOL (MLS)	FECAL STREP Nos.Per 100 MLS	WATER TEMPERATURE AT COLLECTION (°C)	RATIO FC/FS
12	Silver Bow Creek above Blacktail Creek.									
	June 12, '72	10:00 A	20	<1					17°	
	July 24, '72	8:50 A	11.1	** <1					16°	
	June 18, '73	8:55 A	80	* <1					8°	
	June 21, '73	9:05 A	60	<1					14°	
13	Silver Bow Creek below demestic manganese plant and Montana Pole Treating Plant and above sewage treatment plant. (Rite-Way Asphalt Company).									
	June 13, '72	8:30 A	.1						12°	
	July 24, '72	9:00 A	11.1	**0					15°	
	June 21, '73	9:10 A	40	*3					12°	
	June 18, '73	9:05 A	84	*90					6°	
14	Silver Bow Creek above Rocker.									
	June 13, '72	8:45 A	15	*7					11°	
	July 24, '72	9:10 A	11.1	**0					15°	
	June 21, '73	9:20 A	15	400					12°	
15	Silver Bow Creek between Stauffer and Ramsay at the south end of Laird Street.									
	June 13, '72	8:55 A	4	*25					12°	
	July 24, '72	9:25 A	11.1	**0					15°	

** MPN, result of multiple tube fermentation.

TABLE I, CONT.

STATION	DATE	TIME	TOTAL COLIFORM VOL (MLS)	TOTAL COLIFORM Nos. Per 100 MLS	FECAL COLIFORM VOL (MLS)	FECAL COLIFORM Nos.Per 100 MLS	FECAL STREP VOL (MLS)	FECAL STREP Nos. Per 100 MLS	WATER TEMPERATURE AT COLLECTION (°C)	RATIO FC/FS
15	June 18, '73	9:30 A	15	280					6°	
Cont.	June 21, '73	9:35 A	15	500					12°	
18	Silver Bow Creek above German Gulch at Butte, Anaconda, & Pacific; Milwaukee and Burlington Northern Railroads.									
	June 13, '72	9:15 A	1	*7					11°	
	July 24, '72	10:05 A	11.1	**0					15°	
	June 18, '73	10:00 A	15	190					5°	
	June 21, '73	9:55 A	15	*670					12°	
19	German Gulch above Silver Bow Creek.									
	June 13, '72	9:15 A	60	62					5°	
	July 18, '72	7:40 A	100	34					8°	
20	Gregson Creek above Gregson, 1 mile southwest of Gregson - Crackerville Road on Peterson Ranch Road.									
	June 13, '72	9:45 A	19	470					9°	
	July 18, '72	7:55 A	5	560					12°	
	July 20, '72	10:15 A	15	630					9°	
21	Gregson Creek below Gregson, immediately downstream from culvert under Butte, Anaconda, & Pacific Railroad; northeast side of railroad just below convergence with other creek.									
	June 13, '72	9:35 A	20	*140					15°	
	July 18, '72	8:00 A	30	TNTC					22°	
	July 20, '72	10:20 A	20	310					20°	
22	Silver Bow Creek at U.S. Highway 10A at crossing.									
	June 13, '72	10:15 A	20	<1					9°	
	July 24, '72	9:40 A	11.1	** <1					14°	

TABLE I, CONT.

			TOTAL COLIFORM		FECAL COLIFORM		FECAL STREP			
STATION	DATE	TIME	VOL (MLS)	Nos.Per 100 MLS	VOL (MLS)	Nos.Per 100 MLS	VOL (MLS)	Nos.Per 100 MLS	WATER TEMPERATURE AT COLLECTION (°C)	RATIO FC/FS
22 Cont.	June 18, '73	10:25 A	15	190					5°	
	June 21, '73	10:20 A	15	*590					13°	
23	Willow Creek on Highway 275 crossing east of Opportunity, Montana.									
	June 14, '72	8:40 A	5	1800					11°	
	July 18, '72	8:15 A	10	310					11°	
	July 20, '72	10:35 A	25	490					9°	
24	Mill and Willow Creek at Warm Springs (by pass at crossing by State Game Farm).									
	June 14, '72	9:45 A	15	400					10°	
	July 18, '72	9:25 A	80	33					13°	
25	Mill Creek above Deer Lodge Valley, 1.7 miles south of Highway 10A on Mill Creek Road.									
	June 13, '72	10:05 A	60	72					7°	
	July 18, '72	8:30 A	220	35					10°	
	July 20, '72	10:45 A	100	35					7°	
26	Mill Creek above Willow Creek on Highway. Golf course west of Opportunity under Highway 10.									
	June 14, '72	8:50 A	15	270					7°	
	July 18, '72	8:20 A	90	79					10°	
27	Clarks Fork at lower pH shack.									
	June 14, '72	9:50 A	75	130					13°	
	July 18, '72	9:35 A	26	89					16°	
	July 20, '72	11:05 A	50	190					10°	
	June 18, '73	10:40 A	60	85					7°	
	June 21, '73	10:35 A	100	19					15°	
28	Warm Springs Creek above Hyer's Dam. 4.0 miles west of Haufbrau (west of city limits) off 10A and across from Anaconda Limestone Quarry.									
	June 14, '72	9:10 A	60	42					5°	

TABLE I, CONT.

			TOTAL COLIFORM		FECAL COLIFORM		FECAL STREP			
STATION	DATE	TIME	VOL (MLS)	Nos.Per 100 MLS	VOL (MLS)	Nos.Per 100 MLS	VOL (MLS)	Nos.Per 100 MLS	WATER TEMPERATURE AT COLLECTION (°C)	RATIO FC/FS
28 Cont.	July 18, '72	8:50 A	250	18					7°	
29		Warm Springs Creek above Anaconda, 0.2 miles above Haufbrau.								
	June 14, '72	9:20 A	79	190					6°	
	July 18, '72	8:55 A	35	130					8°	
30		Warm Springs Creek below Anaconda, 0.6 miles west of State Highway 48 on Lost Creek Road crossing.								
	June 14, '72	9:30 A	19	400					7°	
	July 18, '72	9:15 A	80	75					11°	
31		Warm Springs Creek mouth (anywhere between highway and Clark Fork River).								
	June 14, '72	10:00 A	4	920					8°	
	July 18, '72	9:30 A	25	TNTC					15°	
	July 20, '72	11:00 A	5	1100					9°	
32		Clark Fork River below Warm Springs, 2 miles north of Warm Springs store on Highway 10 then to right on County Road ½ mile to Clark Fork River Crossing.								
	June 14, '72	10:10 A	19	510					11°	
	July 19, '72	10:30 A	15	*120					11°	
	July 20, '72	11:15 A	15	490					10°	
	June 18, '73	10:50 A	4	570					7°	
	June 21, '73	10:45 A	79	*47					15°	
33		Basin Creek at Basin Creek picnic area, 100 yards below fence with "NO TRESPASSING" sign on southeast end of the picnic area.								
	June 12, '72	9:00 A	60	TNTC					8°	
	June 14, '72	10:15 A	1	*11,000					11°	
	June 19, '72	9:25 A	1.5	9400			60	*12	7°	
	June 22, '72	9:25 A	1.2	6700			60	*3	8°	

TABLE I, CONT.

			TOTAL COLIFORM		FECAL COLIFORM		FECAL STREP			
STATION	DATE	TIME	VOL (MLS)	Nos.Per 100 MLS	VOL (MLS)	Nos.Per 100 MLS	VOL (MLS)	Nos.Per 100 MLS	WATER TEMPERATURE AT COLLECTION (^{o}C)	RATIO FC/FS
34	Storm Sewer outlet at southeast corner of access road to the Interstate 90 due east.									
	June 26, '72	A	0.001	6,600,000			0.01	610,000		
	Aug. 15, '72	9:30 A	0.0001	27,000,000	0.001	*7,400,000	0.01	440,000		16.8:1
	Aug. 15, '72	9:15 A	0.0002	18,000,000	0.001	*8,900,000	0.01	640,000		13.9:1
	March 24, '73	1:00 P			0.02	65,000	0.03	6,700		9.7:1
	June 14, '73	9:00 A	0.01	82,000	0.1	25,000	0.1	36,000		0.69:1
	June 26, '73	11:15 A	0.06	150,000	0.5	10,000	0.04	55,000	11°	0.18:1
35	Grove Gulch Creek, intermittent above City-County Land Fill Dump on Little Basin Creek Road, 1.8 miles above its junction with Montana Street.									
	July 27, '72	9:05 A	15	440					11°	
36	Grove Gulch Creek, intermittent, below City-County Land Fill Dump at Montana Street.									
	July 27, '72	9:10 A	4	650					11°	
37	Concrete conduit, 3 feet in diameter emptying into Blacktail Creek, 20 feet west of alley, 2½ blocks south of Front Street. Alley is directly behind Safeway Store adjacent to Front Street and South Montana Street.									
	June 14, '73	9:15 A	0.1	TNTC	0.1	69,000	1.0	7,900	11°	8.73:1
38	Concrete conduit, 3 feet diameter emptying into Silver Bow Creek, 53 feet from east edge of Harrison Avenue.									
	June 14, '73	9:25 A	1.0	2100	1.0	*100	5.14	*390	11°	0.25:1
S1	Basin Creek, west side, ca. 15 feet north of footbridge in front of large white house with red trim; located east southeast of Village Inn Pizza parlor (3 blocks).									
	July 10, '72	9:30 A	0.001	4,700,000			0.1	45,000		

TABLE I, CONT.

STATION	DATE	TIME	TOTAL COLIFORM VOL (MLS)	TOTAL COLIFORM Nos. Per 100 MLS	FECAL COLIFORM VOL (MLS)	FECAL COLIFORM Nos. Per 100 MLS	FECAL STREP VOL (MLS)	FECAL STREP Nos. Per 100 MLS	WATER TEMPERATURE AT COLLECTION (°C)	RATIO FC/FS
S1 Cont.	Aug. 2, '72	9:55 A	0.01	450,000	0.5	TNTC	0.1	*1,000	20°	
	Aug. 7, '72	9:55 A	0.001	4,800,000	0.01	1,700,000	4	1,300	17°	13.10:1
S4	North side of Blacktail Creek ca. 15 yards west of Johns Street, a dead end, and 6 inches wide, 3 inches deep, milky color running freely, 325 feet measured, sample.									
	July 10, '72	10:00 A	0.011*	*1,400,000			0.1	*11,000		
	July 11, '72		0.011*	*1,800,000			0.5	120,000		
	Aug. 2, '72	10:10 A	0.001	*500,000	0.5	*110,000	0.1	*208,000	12°	0.52:1
	Aug. 7, '72	10:20 A	0.01	560,000	0.05	92,000	0.14*	*15,000		6.13:1
S5	100 Feet below S4, a seep, 12 feet above the fence, 69 feet below S4, north side.									
	July 10, '72	10:00 A	0.001	*23,000,000			0.01	*20,000		
S6	26 Feet below fence below S5, north side, 5 inches by 2 inches, milky color running freely.									
	July 10, '72	10:15 A	0.001	*8,200,000			0.111*	0		
	July 11, '72		0.001	*30,000,000			0.1	47,000		
	Aug. 2, '72	10:15 A	0.001	7,300,000	0.5	TNTC	3.5	*310	10°	
	Aug. 7, '72	10:20 A	0.0014*	*1,000,000	0.006*	*320,000	7	940	9°	240.0:1
S7	Downstream from S6, north side of Blacktail Creek, below tuft of grass, 8 inches concrete conduit, 1½ inches, water slow, clear, toilet tissue downstream in the creek, across Interstate 90 from "Harrison Avenue South" sign, directly south of house.									
	July 11, '72	11:00 A	0.01	350,000			0.1	*2,000		
	Aug. 2, '72	10:20 A	0.01	*850,000	5	Conf*	1.0	TNTC	12°	8.83:1
	Aug. 7, '72	10:25 A	0.014*	800,000	0.01	300,000	0.1	34,000	14°	8.2:1
S8	Blacktail Creek due south of KOA Campground, Butte; milky colored effluent from trashy area, near willows.									
	July 11, '72	11:15 A	0.111	<1			1.0	100		

TABLE II GEOMETRIC MEANS, RANGES AND RATIOS OF FECAL COLIFORM TO FECAL STREPTOCOCCAL COLIFORM POPULATIONS AT STATIONS INDICATED.

	TOTAL COLIFORM		FECAL COLIFORM		FECAL STREP		AVERAGE
STATION	GEOM. MEAN	RANGE	GEOM. MEAN	RANGE	GEOM. MEAN	RANGE	RATIO FC/FS
1	44	12-100					
2	62	14-170					
3	350	200-490					
4	140	40-220					
5	110	29-400					
6	160	48-340					
7	450	150-980					
11	4100	2300-7200	1700	760-2300	1800	350-9200	1.1:1
11A	6000	3200-9700	690	340-1400	390	110-1300	3.26:1
11A1	170	130-260	11	7-17	140	89-250	0.076:1
11A2	280	0-1x10^4	71	0-900	95	85-100	4.53:1
11A3	1400	160-6700	170	12-1100	180	84-400	1.69:1
11B	1200	460-3200	4	0-4	220	120-320	0.03:1
11C	260	53-1300	1	0-1	80	40-160	0
12	<1	<1					
13	7	0-90					
14	14	0-400					
15	43	0-500					
18	34	0-670					

TABLE II, CONT.

STATION	TOTAL COLIFORM		FECAL COLIFORM		FECAL STREP		AVERAGE RATIO FC/FS
	GEOM. MEAN	RANGE	GEOM. MEAN	RANGE	GEOM. MEAN	RANGE	
19	46	34-62					
20	550	470-630					
21	210	140-310					
22	18	<1-590					
23	650	310-1800					
24	120	33-400					
25	45	35-72					
26	150	79-270					
27	80	19-190					
28	28	18-42					
29	160	130-190					
30	170	75-400					
31	1000	920-1100					
32	240	47-570					
33	8900	6700-11,000			6	3-12	
34	2.1×10^6	$82{,}000-27 \times 10^6$	2.5×10^5	$1\times10^4-89 \times 10^5$	1.2×10^5	$6700-64 \times 10^4$	8.25:1
35	440	*440					
36	650	*650					
37	TNTC	*TNTC		*69,000		*7900	8.73:1

TABLE II, CONT.

STATION	TOTAL COLIFORM		FECAL COLIFORM		FECAL STREP		AVERAGE RATIO FC/FS
	GEOM. MEAN	RANGE	GEOM. MEAN	RANGE	GEOM. MEAN	RANGE	
38	2100	*2100		*100		*390	0.25:1
S1	2.2×10^6	$45 \times 10^4 - 48 \times 10^5$	1.7×10^6	17×10^5-TNTC	3900	1000-45,000	13.10:1
S4	9.2×10^5	$5 \times 10^5 - 18 \times 10^5$	1.0×10^5	$92 \times 10^3 - 11 \times 10^4$	4.5×10^4	11,000-208,000	3.33:1
S5	2.3×10^6	*23,000,000				*20,000	
S6	6.5×10^6	$1 \times 10^6 - 3 \times 10^7$		32×10^4-TNTC	340	$0 - 47 \times 10^3$	340.0:1
S7	6.2×10^5	$35 \times 10^4 - 85 \times 10^4$		3×10^5-Conf	8300	$2000 - 34 \times 10^3$	8.52:1
S8		<1				*100	

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* Only one evaluation made.

INVERTEBRATE STUDIES

Macroinvertebrate populations have been used to demonstrate stream conditions relative to pollutants Avery (1969), Gaufin and Tarzwell (1952), and Wilhm (1967) have indicated that benthic populations can express both present and past environmental conditions while chemical surveys indicate conditions only at the time of sampling.

A Surber Sampler* was used to collect macroinvertebrates at indicated stations. Chosen sample sites at respective stations were usually at the edge of a riffle area and near the center of the stream. All rocks within the sampler frame were rubbed to remove clinging organisms. Smaller rocks and gravel were thoroughly mixed and stirred to ensure all organisms were removed. The samples were pooled at each site and placed in pint jars containing 2 percent formaldehyde solution until they could be sorted.

Taxonomic classification was conducted in the lab. Hexapods were counted, and placed in their respective Families. Miscellaneous organisms including annelids, crustaceons and arachnids were lumped as one group. When sorting was complete the organisms were stored in 70 percent ethanol for future reference.

A composite of benthic organisms collected is presented in TABLE III. A diversity index has been calculated for each sample station to summarize the relationship between the numbers of individuals and kinds of organisms. Generally, maximum diversity exists if each individual belongs to a different taxa and a minimum diversity exists if all individuals belong to the same group.

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*Surber Sampler, 25 mesh net, one square foot (0.3^2M) area covered.

A summary of population data for the various stations is presented in TABLE IV. The average numbers of organisms per square foot are presented with the total number of taxa collected. The average number of taxa per square foot was calculated by dividing the total number of taxa found at each station by the total number of square feet from which they were collected. The total number of different taxa collected at each station was divided by the total number of different taxa found throughout the study area to give the percent occurrance.

The diversity index was calculated by using the formula:

$$\text{Diversity Index} = \frac{S-1}{\text{Log } N}$$

Where S = number of taxa and N = number of individuals.

Orders intolerant to pollutants are Ephemeroptera (Mayflies), Trichoptera (Caddisflies) and Plecoptera (Stoneflies). Generally these are predominant in clear unpolluted streams. Diptera (aquatic fly larvae) and Coleoptera (aquatic beetles) are generally quite tolerant to pollutants and are usually predominate in streams that receive large amounts of organic wastes.

Data for stations at which invertebrates were collected indicate rather stable populations of these organisms. However, the total numbers of individuals is very low. There are several factors that may have influenced the productivity of the streams, i.e. purity of water, temperature, concentrations and type of dissolved solids and amount of accumulated aquatic vegetation available.

Blacktail Creek (Stations 1, 2, 3 and 4) shows a decrease of diversity from the higher elevation to the metropolitan area. This is probably due to decreased velocity at decreased gradient with higher water temperature

and accumulation of solid wastes.

Basin Creek (Station 5) shows a low diversity index. The majority of of insects collected were Diptera which were probably in higher numbers because of the sewer effluents emptying into it. Additionally, a very badly decomposed dog carcass which would exert a short-lived effect was found under a bridge near Station S-1 on July 10, 1972.

Tributaries such as German Gulch Creek and Warm Springs Creek above Anaconda show a much higher diversity index which is more revealing of pristine conditions of higher mountain waters.

All other tributaries at lower elevations with slower running waters, higher temperatures and proximity to urbanization, industrialization and their accompanying pollutants show lower indeces.

Silver Bow Creek, because of its physical and chemical properties and obvious lack of fauna was not sampled during the early part study. However, at the conclusion of the study period one sample of Silver Bow Creek one half mile below German Gulch Creek at the German Gulch Road bridge showed 4 Coleoptera, 1 Ephemeroptera and two Diptera. A similar sample taken in Silver Bow Creek above German Gulch Creek was negative.

SUMMARY

Limited base-line information has been acquired on both benthic and bacterial populations of the streams evaluated. Sampling should be continued at selected stations to record or monitor both quantitatively and qualitatively the invertebrate and bacterial populations especially in light of the continued efforts of removal of industrial pollutants of Silver Bow Creek.

TABLE III BENTHIC ORGANISMS COLLECTED

STATION	DATE	ORDER	TOTAL NUMBER COLLECTED	FAMILY AND NUMBER COLLECTED	
1	Blacktail Creek above Thompson Park; on Roosevelt Drive, 1.2 miles above Milwaukee trestle at log cabin ranch house, below fence. I,B.				
	June 20, 1972	Coleoptera	3	Elmidae	3
		Ephemeroptera	5	Baetidae Heptagenidae	1 4
		Plecoptera	3	Perlidae	3
		Trichoptera	3	Hydropsychidae	3
		Diptera	2		2
2	Blacktail Creek below Thompson Park at Nine-mile (Junction of Continental Drive and U.S. Highway 10). South side of Highway 10. I,B.				
	June 20, 1972	Ephemeroptera	6	Baetidae Heptagenidae	4 2
		Diptera	3		3
		Miscellaneous	2		2
	April 17, 1973	Miscellaneous	2		2
3	Blacktail Creek above Country Club on Country Club Drive exit at crossing about ¼ mile west of Country Club Drive exit. I,B.				
	June 20, 1972	Ephemeroptera	10	Baetidae Heptagenidae	3 7
		Plecoptera	1	Chloroperlidae	1
		Diptera	2		2
		Miscellaneous	2		2
	April 17, 1973	Diptera	1		1
		Miscellaneous	3		3
4	Blacktail Creek above Basin Creek and below Country Club immediately above convergence with Basin Creek at Father Sheehan Park. I,B.				

TABLE III, CONT.

STATION	DATE	ORDER	TOTAL NUMBER COLLECTED	FAMILY AND NUMBER COLLECTED	
4 (Cont.)	June 20, 1972	Ephemeroptera	7	Baetidae	5
				Heptagenidae	2
		Miscellaneous	1		1
	April 17, 1973	Coleoptera	1	Elmidae	1
5	Basin Creek above Blacktail Creek at end of culvert under the Interstate 90 at Father Sheehan Park. I,B.				
	June 20, 1972	Miscellaneous (includes worms and Diptera)	57		57
	April 17, 1973	Ephemeroptera	1	Baetidae	1
		Plecoptera	1	Chloroperlidae	1
		Diptera	17		17
		Miscellaneous	118		118
6	Blacktail below Basin Creek, 100 yards downstream from convergence with Basin Creek at Father Sheehan Park. I,B.				
	June 20, 1972	Ephemeroptera	68	Baetidae	39
				Heptagenidae	29
		Plecoptera	4	Perlodidae	4
		Trichoptera	4	Hydropsychidae	3
				Hydroptilidae	1
	April 17, 1973	Ephemeroptera	20	Baetidae	20
		Plecoptera	3	Chloroperlidae	1
				Perlodidae	2
		Diptera	6		6
8	Yankee Doodle Creek above tailings pond. I.				
	June 20, 1972	Ephemeroptera	8	Baetidae	5
				Heptagenidae	3
		Trichoptera	23	Limnephilidae	23

TABLE III CONT.

STATION	DATE	ORDER	TOTAL NUMBER COLLECTED	FAMILY AND NUMBER COLLECTED	
19	German Gulch above Silver Bow Creek. I,B.				
	June 19, 1972	Coleoptera	5	Elmidae	5
		Ephemeroptera	9	Baetidae	6
				Heptagenidae	3
		Trichoptera	1	Rhyacophilidae	1
		Miscellaneous	1		1
	April 18, 1973	Coleoptera	2		2
		Ephemeroptera	20	Baetidae	6
				Heptagenidae	14
		Plecoptera	5	Chloroperlidae	2
				Perlodidae	3
		Trichoptera	2	Rhyacophilidae	2
		Miscellaneous	4		4
23	Willow Creek on Highway 275 crossing east of Opportunity, Montana. I,B.				
	June 21, 1972	Coleoptera	14	Elmidae	14
		Ephemeroptera	41	Baetidae	3
				Heptagenidae	38
		Plecoptera	1	Chloroperlidae	1
		Miscellaneous	157		157
	April 18, 1973	Ephemeroptera	4	Baetidae	3
				Heptagenidae	1
		Diptera	10		10
		Miscellaneous	44		44
24	Mill and Willow Creek at Warm Springs (by pass at crossing by State Game Farm). I,B.				
	June 21, 1972	Plecoptera	2	Nemouridae	2
		Trichoptera	1	Hydropsychidae	1
		Miscellaneous	8		8
	April 18, 1973	Trichoptera	32	Brachycentridae	2
				Hydropsychidae	30

TABLE III, CONT.

STATION	DATE	ORDER	TOTAL NUMBER COLLECTED	FAMILY AND NUMBER COLLECTED	
24 (Cont.)	April 18, 1973	Diptera	51		51
25	Mill Creek above Deer Lodge Valley, 1.7 miles south of Highway 10A on Mill Creek Road. I,B.				
	June 21, 1972	Ephemeroptera	1	Heptagenidae	1
	April 18, 1973	Coleoptera	9	Elmidae	9
		Ephemeroptera	12	Baetidae	2
				Heptagenidae	10
		Trichoptera	46	Brachycentridae	44
				Psychomyiidae	2
		Diptera	2		2
		Miscellaneous	2		2
26	Mill Creek above Willow Creek on Highway. Golf course west of Opportunity under Highway 10. I,B.				
	June 21, 1972	Coleoptera	1	Elmidae	1
		Ephemeroptera	3	Heptagenidae	3
		Miscellaneous	3		3
	April 18, 1973	Ephemeroptera	82	Baetidae	33
				Heptagenidae	49
		Plecoptera	2	Chloroperlidae	2
		Trichoptera	8	Brachycentridae	2
				Leptoceridae	1
				Rhyacophilidae	5
		Diptera	14		14
27	Clarks Fork at lower pH shack. I,B.				
	April 18, 1973		0		0
28	Warm Springs Creek above Hyer's Dam. 4.0 miles west of Haufbrau (west of city limits) off 10A and across from Anaconda Limestone Quarry. I,B.				
	June 21, 1972	Coleoptera	3	Elmidae	3
		Trichoptera	1	Brachycentridae	1

TABLE III, CONT.

STATION	DATE	ORDER	TOTAL NUMBER COLLECTED	FAMILY AND NUMBER COLLECTED	
28 (Cont.)	June 21, 1972	Miscellaneous	2		2
	April 18, 1973	Coleoptera	5	Elmidae	4
				Unknown	1
		Ephemeroptera	96	Baetidae	73
				Heptagenidae	23
		Plecoptera	7	Chloroperlidae	7
		Trichoptera	46	Brachycentridae	33
				Hydopschidae	2
				Leptoceridae	2
				Psychomyiidae	4
				Rhyacophilidae	5
		Diptera	318		318
		Miscellaneous	15		15
29	Warm Springs Creek above Anaconda, 0.2 miles above Haufbrau. I,B.				
	April 18, 1973	Coleoptera	1	Elmidae	1
		Ephemeroptera	17	Baetidae	15
				Heptagenidae	2
		Trichoptera	9	Brachycentridae	5
				Hydropschidae	2
				Rhyacophilidae	2
				Psychomidae	1
		Diptera	21		21
		Miscellaneous	5		5
30	Warm Springs Creek below Anaconda, 0.6 miles west of State Highway 48 on Lost Creek Road crossing. I,B.				
	April 18, 1973	Coleoptera	42	Elmidae	42
		Ephemeroptera	33	Baetidae	32
				Heptagenidae	1
		Trichoptera	3	Brachycentridae	1
				Hydropschidae	1
				Rhyacophilidae	1
		Diptera	42		42

TABLE III, CONT.

STATION	DATE	ORDER	TOTAL NUMBER COLLECTED	FAMILY AND NUMBER COLLECTED	
31	Warm Springs Creek mouth (anywhere between highway and Clark Fork River). I,B.				
	April 18, 1973	Ephemeroptera	3	Baetidae	3
		Diptera	22		22
		Miscellaneous	10		10
32	Clark Fork River below Warm Springs, 2 miles north of Warm Springs store on Highway 10 then to right on County Road ½ mile to Clark Fork River crossing. I,B.				
	April 18, 1973	Ephemeroptera	1	Heptagenidae	1
		Trichoptera	2	Hydropsychidae	2
		Diptera	53		53

TABLE IV SUMMARY OF POPULATION DATA

	Average No. Organisms/ Sq. Ft.	Total No. Taxa	Avg. No. Taxa/Sq.Ft.	Taxa Percent Occurrence	Diversity Index**	Diversity Index***
1.	16*	5	5.0	39	3.49	4.15
2.	3	1	0.5	8	1.3	2.1
3.	5.5	3	1.5	23	1.8	4.5
4.	4	3	1.5	23	2.2	3.1
5.	1	2	1.0	15	3.3	1.7
6.	51	8	4.0	62	3.0	3.6
8.	31*	3	3.0	23	2.0	2.0
19.	23	6	3.0	46	3.0	4.1
23.	30	4	2.0	31	1.7	2.5
24.	17.5	4	2.0	31	1.3	
25.	34	5	2.5	39	2.2	3.8
26.	49	7	3.5	54	3.0	3.9
27.	0	0	0	0		
28.	79	10	5.0	77	4.1	4.5
29.	27*	7	7.0	54	4.2	4.6
30.	78*	6	6.0	46	2.6	2.9
31.	3*	1	1.0	8	0	1.3
32.	4*	3	3.0	23	3.3	1.7

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*Only one 1/sq. ft. sample taken.
** Includes Coleoptera, Ephemeroptera, Plecoptera, and Trichoptera only.
*** Includes all counts.

APPENDIX I

SAMPLE STATIONS FOR SILVER BOW AND BLACKTAIL CREEKS

1. Blacktail Creek above Thompson Park; on Roosevelt Drive, 1.2 miles above Milwaukee trestle at log cabin ranch house, below fence. I,B.

2. Blacktail Creek below Thompson Park at Nine-mile (Junction of Continental Drive and U.S. Highway 10). South side of Highway 10. I,B.

3. Blacktail Creek above Country Club on Country Club Drive exit at crossing about ¼ mile west of Country Club Drive exit. I,B.

4. Blacktail Creek above Basin Creek and below Country Club immediately above convergence with Basin Creek at Father Sheehan Park. I,B.

5. Basin Creek above Blacktail Creek at end of culvert under the Interstate 90 at Father Sheehan Park. I,B.

6. Blacktail below Basin Creek, 100 yards downstream from convergence with Basin Creek at Father Sheehan Park. I,B.

7. Blacktail Creek above Silver Bow Creek. I,B.

8. Yankee Doodle Creek above tailings pond. I.

9. Silver Bow Creek above tailings pond (intermittent).

10. Woodville Gulch above Tropic Pond, crossing east of road to Tropic Pond.

11. Stream from Columbia Gardens (Horse Canyon), ditch along railroad immediately above the junction of Continental Drive and Montgomery Avenue (road to Columbia Gardens). B.

THE FOLLOWING ARE VARIATIONS OF SAMPLE STATION 11. BACTERIAL EVALUATIONS ONLY.

11A Columbia Gardens Creek 0.7 miles above Station 11 on Columbia Garden Road. B.

11B Columbia Gardens Creek tributary 20 feet south of Station 11. B.

11C Columbia Gardens Creek above Merry-Go-Round in picnic area. B.

11A1 Columbia Gardens Creek above Columbia Gardens Septic Tank. B.

11A2 Columbia Gardens Septic Tank Sewage Effluent. B.

11A3 Columbia Gardens Creek below road culvert immediately below Septic Tank (11A1 and 11A2). B.

12. Silver Bow Creek above Blacktail Creek. I,B.
13. Silver Bow Creek below domestic manganese plant and Montana Pole Treating Plant and above sewage treatment plant. (Rite-Way Asphalt Company). B.
14. Silver Bow Creek above Rocker. I,B.
15. Silver Bow Creek between Rocker at RR bridge just east of Ramsay and Ramsay.
16. Silver Bow Creek in Brown's Gulch above Chinaman's Spring below Interstate.
17. Chinaman Spring at Interstate Crossing.
18. Silver Bow Creek above German Gulch at Butte, Anaconda, & Pacific; Milwaukee and Burlington Northern Railroads. I,B.
19. German Gulch above Silver Bow Creek. I,B.
20. Gregson Creek above Gregson, 1 mile southwest of Gregson - Crackerville Road on Peterson Ranch Road. B.
21. Gregson Creek below Gregson, immediately downstream from culvert under Butte, Anaconda, & Pacific Railroad; northeast side of railroad just below convergence with other creek. B.
22. Silver Bow Creek at U.S. Highway 10A at crossing. I,B.
23. Willow Creek on Highway 275 crossing east of Opportunity, Montana. I,B.
24. Mill and Willow Creek at Warm Springs (by pass at crossing by State Game Farm). I,B.
25. Mill Creek above Deer Lodge Valley, 1.7 miles south of Highway 10A on Mill Creek Road. I,B.
26. Mill Creek above Willow Creek on Highway. Golf course west of Opportunity under Highway 10. I,B.
27. Clarks Fork at lower pH shack. I,B.
28. Warm Springs Creek above Hyer's Dam. 4.0 miles west of Haufbrau (west of city limits) off 10A and across from Anaconda Limestone Quarry. I,B.

APPENDIX I, Continued

29. Warm Springs Creek above Anaconda, 0.2 miles above Haufbrau. I,B.

30. Warm Springs Creek below Anaconda, 0.6 miles west of State Highway 48 on Lost Creek Road crossing. I,B.

31. Warm Springs Creek mouth (anywhere between highway and Clark Fork River). I,B.

32. Clark Fork River below Warm Springs, 2 miles north of Warm Springs store on Highway 10 then to right on County Road ½ mile to Clark Fork River crossing. I,B.

APPENDIX II

SAMPLE STATIONS ADDED FOR BACTERIAL EVALUATIONS DURING THE COURSE OF THE PROJECT

33. Basin Creek at Basin Creek picnic area, 100 yards below fence with "NO TRESPASSING" sign on southeast end of the picnic area. B.

34. Storm Sewer outlet at southeast corner of access road to the Interstate 90 due east, at foot of Excelsior Avenue.

35. Grove Gulch Creek, intermittent above City-County Land Fill Dump on Little Basin Creek Road, 1.8 miles above its junction with Montana Street.

36. Grove Gulch Creek, intermittent, below City-County Land Fill Dump at Montana Street.

37. Concrete conduit, 3 feet in diameter emptying into Silver Bow Creek 20 feet west of alley, 2½ blocks south of Front Street. Alley is directly behind Safeway Store adjacent to Front Street and south Montana Street.

38. Concrete conduit, 3 feet diameter emptying into Silver Bow Creek, 53 feet from east edge of Harrison Avenue.

39. Conduit, 3/4 foot diameter, half way up stream bank of Silver Bow Creek, 188 feet from east edge of Harrison Avenue.

APPENDIX III

SAMPLE STATIONS DESCRIBED BELOW ARE LABELED S AND ARE BELIEVED TO BE SEWER OR SEPTIC TANK EFFLUENTS, WERE ADDED TO THE STUDY DURING ITS COURSE

S1 Basin Creek, west side, ca. 15 feet north of footbridge in front of large white house with red trim; located east southeast of Village Inn Pizza Parlor (3 blocks).

S2 Blacktail Creek south of Union 76 Service Station, east of Harrison Avenue, north of Interstate 90, north side of the creek, no sample taken - photo only; ca. 35 feet west of culvert abundant oil, some clear water.

S3 Texaco Service Station, west side of Harrison Avenue, north of Interstate 90; drainpipe about 35 feet downstream from end of steel culvert under Harrison Avenue, north side of creek signs of draining used motor oil and water. No sample taken.

S4 North side of Blacktail Creek ca. 15 yards west of Johns Street, a dead end, and 6 inches wide, 3 inches deep, milky color running freely, 325 feet measured, sample.

S5 100 Feet below S4, a seep, 12 feet above the fence, 69 feet below S4, north side.

S6 26 Feet below fence below S5, north side, 5 inches by 2 inches, milky color running freely.

S7 Downstream from S6, north side of Blacktail Creek, below tuft of grass, 8 inches concrete conduit, 1½ inches, water slow, clear, toilet tissue downstream in the creek, across Interstate 90 from "Harrison Avenue South" sign, directly south of house.

S8 Blacktail Creek due south of KOA Campground, Butte; milky colored effluent from trashy area, near willows.

LITERATURE CITED

Avery, E. L. 1969. Effects of Domestic Sewage on Aquatic Insects and Salmonids of the East Gallatin River, Montana. Unpublished Master of Science thesis. Montana State University, Bozeman, Montana.

Bissonnette, G. K. 1971. A Microbiological and Chemical Investigation of the Effects of Multiple Use on Water Quality of High Mountain Watersheds. Masters' Thesis, Montana State University, Bozeman, Montana.

Gaufin, A. R. and Tarzwell, C. M. 1955. Environmental Changes in a Polluted Stream during Winter. American Midland Naturalist. 54:1-78.

Wilhm, J. L. 1967. Comparison of Some Diversity indeces Applied to Populations of Benthic Macroinvertebrates in a stream receiving organic wastes: Journal WPCF, October 1967, pp. 1673-83.